22 AUG 2001

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No. :

U.S. National Serial No. :

Filed :

PCT International Application No. : PCT/FR99/03201

VERIFICATION OF A TRANSLATION

I, Susan POTTS BA ACIS

Director to RWS Group plc, of Europa House, Marsham Way, Gerrards Cross, Buckinghamshire, England declare:

That the translator responsible for the attached translation is knowledgeable in the French language in which the below identified international application was filed, and that, to the best of RWS Group plc knowledge and belief, the English translation of the international application No. PCT/FR99/03201 is a true and complete translation of the above identified international application as filed.

I hereby declare that all the statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the patent application issued thereon.

Date: June 8, 2001

Signature of Director :

For and on behalf of RWS Group plc

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PCT

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International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International patent classification[7]:
H04Q 7/38, H04B 7/08, 7/02 — A1

(11) International publication number: WO 00/38462

(43) International publication date: 29 June 2000 (29.06.00)

(21) International application number: PCT/FR99/03201

(22) International filing date: 20 December 1999 (20.12.99)

(30) Data relating to the priority:
98/16,220 22 December 1998 (22.12.98) US

(81) Designated states: CA, CN, JP, US, European Patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With the International Search Report.

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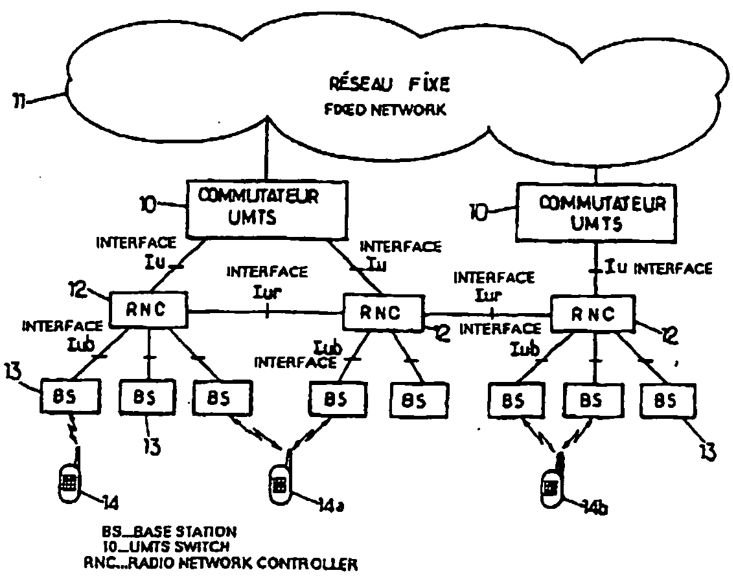
As printed

(54) Title: CELLULAR RADIO COMMUNICATION METHOD, CONTROL EQUIPMENT AND MOBILE STATIONS USING SAID METHOD

(54) Titre: PROCEDE DE RADIOCOMMUNICATION CELLULAIRE, EQUIPEMENTS DE CONTROLE ET STATIONS MOBILES METTANT EN OEUVRE CE PROCEDE

(57) Abstract

The invention concerns a mobile station comprising several receiving units for processing, in macrodiversity mode, respective radio signals transmitted by several distinct base stations and bearing an identical information. When predetermined conditions are fulfilled, the method consists in relinquishing at least partially the macrodiversity mode for the mobile station; commanding one or several base stations to transmit to the mobile station radio signals bearing different data, and controlling the mobile station so that its reception units process said radio signals to receive said different data.



(57) Abrégé

La station mobile comporte plusieurs unités de réception pour traiter, en mode de macrodiversité, des signaux radio respectifs émis par plusieurs stations de base distinctes et porteurs d'une information identique. Lorsque des conditions déterminées sont remplies, on renonce au moins partiellement au mode de macrodiversité pour la station mobile, on commande une ou plusieurs des stations de base pour émettre vers la station mobile des signaux radio porteurs d'informations différentes, et on commande la station mobile pour que ses unités de réception traitent ces signaux radio afin de recevoir lesdites informations différentes.

METHOD FOR CELLULAR-RADIO COMMUNICATION, CONTROL EQUIPMENT AND MOBILE STATIONS IMPLEMENTING THIS METHOD

The present invention relates to cellular-radio communications using macrodiversity techniques.

The infrastructure of a cellular network comprises base stations distributed over the region of coverage in order to communicate with mobile stations situated in the zones, or cells, which they serve. The technique of macrodiversity consist in providing for a mobile station to be able to communicate simultaneously with separate base stations in such a way that, in the down direction (from the base stations to the mobile stations), the mobile station receives the same information several times and that, in the up direction, the radio signal sent out by the mobile station is picked up by the base stations in order to form different estimates which are then combined within the infrastructure of the network.

Macrodiversity confers gains on reception which enhances the performance of the system by virtue of the combining of different observations of the same information. It also makes it possible to achieve smooth intercellular transfers ("soft handoff") when the mobile station is on the move.

The cellular networks may include sectorized cells, in which the base station has a grouping of antennas which is arranged to send out different radio signals in different directions defining the sectors of the cell. Macrodiversity can also be provided for between several sectors of the same cell, the mobile station then receiving separate signals sent out from the same base station. "Softer handoff" is then spoken of, instead of "soft handoff" (see C. C. Lee and R. Steele, "Effect of Soft and Softer Handoffs on CDMA System Capacity", IEEE Transactions on Vehicular

Technology, Vol. 47, No 3, August 1998, pages 830-841). For the purposes of the present application, the term "base station" will designate either the base station of a non-sectorized cell, or the means which a base station uses in order to define one of the sectors of a sectorized cell.

The techniques of macrodiversity are employed particularly in code-division multiple-access (CDMA) networks. They are provided for in the third-generation cellular system known as UMTS ("Universal Mobile Telecommunications System"), within the framework of wideband CDMA (W-CDMA) for frequency-duplex (FDD) communications. UMTS has been adopted, in its main outlines, by ETSI (European Telecommunications Standard Institute) and proposed for standardization to the International Telecommunications Union (ITU-R). ETSI is distributing detailed documentation on it, "The ETSI UMTS Terrestrial Radio Access (UTRA) ITU-R RTT Candidate Submission" on the Internet (http://www.etsi.org/smg/utra/utra.pdf).

The necessity for mobile stations to be able to operate in macrodiversity mode increases the complexity of the stations. It is usually estimated that, in UMTS-type networks, the mobile stations will operate from 20 to 50% of the time in macrodiversity mode. There are instances where the gains obtained via macrodiversity will be slight or ineffective, for example if other diversity techniques are implemented (highly redundant error-correcting coding, spatial diversity, time diversity via an ARQ-type repetition protocol, etc.). Moreover, the operator of a UMTS network may know, a priori, that macrodiversity will not produce substantial gains in a given cell having regard to the characteristics of the cell. The additional complexity of mobiles due to macrodiversity is therefore not fully utilized.

One object of the present invention is to make better use of the means which have to be provided in mobile stations for operation in macrodiversity mode.

Hence the invention proposes a method for radio communication between a mobile station and a cellular-network infrastructure including a set of base stations, in which the mobile station includes at least two receiving units for processing, in macrodiversity mode, respective radio signals sent out by at least two separate base stations and carrying identical information. When specified conditions are fulfilled, the macrodiversity mode is at least partially dispensed with for the mobile station, one or more of the base stations is or are made to send the mobile station at least two radio signals carrying different sets of information, and the mobile station is made to have its receiving units process these radio signals so as to receive the said different sets of information.

The multiple receiving units of the mobile station can then be used in various circumstances other than the macrodiversity mode, which is then deliberately dispensed with, at least partly. On the other hand, the method does not prevent macrodiversity being used in the up direction.

The method particularly makes it possible to increase the communications throughput to a mobile station, or to establish links with new mobile stations, under circumstances where constraints would otherwise present an obstacle. These constraints may be related to the saturation of the radio resources which can be allocated in one or other of the cells with which the mobile station can communicate in macrodiversity mode, or else to the necessity of generating substantial signaling traffic in order to be in a position to allocate such resources.

In a first version of the method, when at least some of the specified conditions are fulfilled, the

radio signals carrying different sets of information are sent out by the same base station.

This may apply particularly to CDMA systems in which the base station, in the case of the down communication direction, operates with multiple communications channels defined by channel-separation codes selected from a set of codes with variable spreading factor in a defined range, the channel-separation codes being selected with spreading factors depending on the information throughputs required respectively on the channels, with an overall constraint of orthogonality between the codes employed at every instant by the base station.

In particular, in cases where a communication is established from the base station to the mobile station with an information throughput corresponding to a first spreading factor such that it is not possible to select a new code while obeying the overall orthogonality constraint, multiple channels are formed, defined respectively by codes obeying the overall orthogonality constraint and the respective spreading factors of which are greater than the first spreading factor, the information throughput of the communication being distributed between these multiple channels which transport respective radio signals each processed by at least one of the receiving units of the mobile station.

This makes it possible to establish a communication without macrodiversity in cases where the establishing of this communication while preserving the possibility of macrodiversity would impose a redistribution of the codes allocated to various communications in progress and would therefore generate substantial signaling traffic.

When it is known that macrodiversity does not contribute substantial gains (for example having regard to the specific characteristics of the cell, or else to the fact that the communication is using an ARQ-type

protocol), it may therefore be advantageous to dispense with macrodiversity in order to limit the signaling traffic.

The spreading factors of the codes of the set are typically of the form 2^{L-k}, L being a positive integer and k an integer variable such that $0 \le k \le L$, a channel-separation code of the form 2^{L-k} corresponding to an information throughput of $2^{k-L}.D$, where D is a defined maximum code throughput. In cases where a communication is established from the base station to the mobile station requiring an information throughput equal to $\alpha.D$ with $2^{-m-1} < \alpha \le 2^{-m} - 2^{-L}$ and m an integer such that $0 \le m < L-1$, then at least two codes of the set are selected obeying the overall orthogonality constraint in such a way that the sum of the inverses of the spreading factors of the codes selected is less than 2^{-m}, so as to form multiple channels defined respectively by the selected codes, the information throughput of the communication being distributed between these multiple channels which transport respective radio signals each processed by at least one of the receiving units of the mobile station.

These provisions make it possible to adjust the spreading codes allocated to the communications throughput required, so as to avoid using non-indispensable code resources.

In a second version of the method, when at least some of the specified conditions are fulfilled, the radio signals carrying different sets of information are sent out respectively by at least two separate base stations.

In this case, two separate base stations are used to send the different sets of information to the same mobile station. This is useful when there is saturation of the radio resources capable of being allocated to one of the base stations. In particular,

the radio signals carrying different sets of information can be sent out respectively by at least first and second separate base stations after the following three conditions have been fulfilled:

- the mobile station is currently operating in macrodiversity mode in order to process radio signals sent out respectively by the first and second base stations and carrying identical information;

- channel-allocation resources of the first base station are saturated; and

- an increase in the quantity of information to be transmitted to the mobile station is required.

Another aspect of the present invention relates to control equipment of a cellular-radio communications network comprising a set of base stations and of mobile stations, at least some of the mobile stations including at least two receiving units in order, in macrodiversity mode, to process respective radio signals sent out by at least two separate base stations and carrying identical information. The equipment comprises means for control of at least one base station for allocating, to the base station, radio communications resources for a down communications direction and for causing corresponding signaling messages to be sent to mobile stations served by this base station. These control means are configured to cause a mobile station at least partially to dispense with the macrodiversity mode when the specified conditions are fulfilled, while causing one or more of the base stations to send out, to the mobile station, at least two radio signals carrying different sets of information, and while causing the mobile station to have its receiving units process these radio signals so as to receive the said different sets of information.

The invention also relates to a mobile station for radio communication with a cellular network the infrastructure of which includes a set of base

stations, comprising at least two receiving units for processing respective radio signals, means for allocating radio resources to the receiving units in response to signaling messages received from the infrastructure of the network, and combining means for combining outputs of the receiving units in a macrodiversity mode in which at least some of the said radio signals are sent out by at least two separate base stations and are carrying identical information. In response to certain of the signaling messages, the allocation means at least partially dispense with the macrodiversity mode, deactivating the combining means, the receiving units then processing at least two radio signals carrying different sets of information.

Other features and advantages of the present invention will emerge in the following description of non-limiting embodiment examples, by reference to the attached drawings, in which:

- Figure 1 is a diagram of a UMTS network to which the invention may be applied;
- Figure 2 is a diagram of a base station of the network and of its controller implementing the invention;
- Figure 3 is a block diagram of the receiving part of a mobile station according to the invention;
- Figure 4 is a diagram illustrating a set of channel-separation codes which can be used in a cell of the network; and
- Figures 5 to 7 are diagrams of the set of codes, illustrating various allocation strategies capable of being implemented according to the invention.

The invention is described below in its application to a wideband CDMA network having a mode of operation in macrodiversity, such as the W-CDMA system provided for in UMTS for operation in frequency-division duplex (see "FRAMES Multiple Access for UMTS

and IMT-2000" by E. Nikula, at al., IEEE Personal Communications, April 1998, pages 16-24). Figure 1 shows the architecture of a UMTS network supporting this W-CDMA system.

The switches of the mobile service 10 are linked, on the one hand, to one or more fixed networks 11 and, on the other hand, by means of an interface known as *Iu*, to control equipment 12, or RNC equipment ("Radio Network Controller"). Each RNC 12 is linked to one or more base stations 13 by means of an interface known as *Iub*. The base stations 13, distributed over the region of coverage of the network, are capable of communicating by radio with the mobile stations 14, 14a, 14b. Certain RNCs 12 may, moreover, communicate with each other by means of an interface known as *Iur*.

Figure 2 illustrates the organization of the sending part of a base station 13 and of its controller 12. The base station 13 forms a set of down channels via the CDMA technique. The information to be sent out on a channel n is the subject of a first spreading via a sequence called channel-separation code or channel code ("channelization code") CC_n.

The channel codes CC_n are orthogonal codes with variable spreading factor (OVSF codes). They are chosen from a set of codes of the same type as the tree represented in Figure 4. Each code $c_{SF,i}$ ($1 \leq i \leq SF$) is a sequence of SF samples, or chips, each taking the value ±1, with $SF = 2^{L-k}$, L being a positive integer (equal to 8 in the case of UMTS) and k an integer variable such that $0 \leq k \leq L$. The tree is defined by:

$$c_{1,1} = (1),$$

$$c_{2.SF,2i-1} = (c_{SF,i}, c_{SF,i}),$$

$$c_{2.SF,2i} = (c_{SF,i}, -c_{SF,i})$$

The chips of a channel code $c_{SF,i}$ are at a rate of D = 4.096 Mchip/s. They modulate strings of symbols the rate of which is $D/SF = 2^{k-L}.D$, that is to say that

the spreading factor is equal to SF = 2^{L-k}. The symbols in question are complex symbols each comprising two signed bits (of value ±1) corresponding to an I channel and to a Q channel.

The channel codes are attributed by the RNC 12, more precisely by the radio-resources control (RRC) function 16 carried out within the RNC. The codes allocated are chosen in such a way as to be orthogonal overall for the same base station. With the tree of codes of Figure 4, two codes having the same spreading factor are always orthogonal, the sum of the chip-to-chip products being zero. Two codes with spreading factors 2^{L-k} and $2^{L-k'}$ are orthogonal if, after they have modulated any two sequences of signed bits with rates respectively of $2^{k-L}.D$ and $2^{k'-L}.D$, the resulting sequences of chips are orthogonal. With the tree arrangement of Figure 4, that amounts to saying that two channel codes are orthogonal if and only if they do not belong to the same branch of the tree, going from the root $c_{1,1}$ to a leaf $c_{L,i}$. The selection of the codes by the RNC 12 obeys this constraint overall: the set of channel codes CC_n used at the same instant by the base station 13 is such that no two codes are found on the same branch. This allows the mobile stations to discriminate the channels which concern them.

The RNC 12, for each channel formed by the base station 13, supplies the spreading factor SF_n and the index i_n of the channel code to be used. A generator 19 of the base station delivers this code $CC_n = c_{SF_n, i_n}$ to a multiplier 20 which modulates the complex symbols transmitted on the corresponding channel.

The sequences of symbols thus modulated are summed at 21 in order to combine the multiple-access channels. The complex signal delivered by the summer 21 is multiplied at 22 by another spreading sequence, or scrambling code, at a rate of 4.096 Mchip/s, supplied

by a generator 23. As transmission from the base station is assumed to be single-carrier transmission, the scrambling code SC is attributed to the base station 13 in its entirety, and is applied identically to all the CDMA channels formed by this base station.

At the output of the multiplier 22, the complex baseband signal is processed by a modulator 24 carrying out the shaping of the pulses and a four-state phase modulation (QPSK) in order to form the radio signal sent out into the cell.

The receiving part of the mobile stations 14, of which Figure 3 shows a block diagram, includes a QPSK demodulator 30 which restores a baseband signal by carrying out the operations which are the counterparts of the modulator 24.

The resultant baseband signal is submitted to several receiving units 31. In the example represented in Figure 3, the mobile station includes two receiving units for providing for operation in macrodiversity on traffic channels (in practice, it may include more of them). Furthermore, a receiving and processing unit 32 provides, in a known way, for reception of the control channels particularly making it possible to recover the information making it possible to know which spreading sequences have to be used by the mobile station.

Each receiving unit 31 receives, from the unit 32, the data identifying the spreading codes to be used, that is to say the spreading factor SF (or, equivalently, the throughput of symbols transmitted on the channel), the index i of the channel code CC_n and the number of the scrambling code SC_n. Generators 33, 34 produce the codes identified by these data, and a multiplier 35 forms the sequence which is the product of these two codes. This sequence is supplied to a rake receiver 36, as well as the spreading factor. The rake receiver 36 conventionally produces estimates of the symbols transmitted on the channel in question, by

estimating the response of the channel on the basis of a pilot sequence included in the signal and by analyzing the output signal from the demodulator 30 along several propagation paths.

The multiple receiving units 31 of the mobile station are intended to operate in macrodiversity mode. In this mode, several base stations 13, having different scrambling codes SC_1, SC_2, send the same information to the mobile station under the control of a master RNC or "serving RNC". In macrodiversity mode, the function of control of the radio links (RLC) 17 of the master RNC 12 addresses the same sequence of bits to be sent out to the base stations involved, and its RRC function allocates them channel codes for transmitting this sequence. These commands are sent via the *Iub* interfaces if the base stations come under the same RNC then forming the master RNC (the case for the mobile station 14b in Figure 1), or via the *Iub* and *Iur* interfaces if they come under different RNCs one of which forms the master RNC (the case for the mobile station 14a in Figure 1). The master RNC or RRC function has the task, moreover, of informing the mobile station of the code resources to be employed, by way of control channels of one or other of the base stations.

The mobile station includes a combining unit 36 which, in macrodiversity mode, receives the symbols estimated by the rake receivers 36 of the units 31. The unit 38 combines these estimates, for example according to the method known as "maximum ratio combining", so as to deliver the symbols finally estimated on the macrodiversity channel.

The invention envisages a certain number of cases where the operation in macrodiversity mode is dispensed with on the down link, so as to take advantage of the multiplicity of receiving units 31 of the mobile station. In this case, the combining unit 38

is deactivated, and the outputs of the rake receivers 36 are delivered on separate processing channels, so as to process, in total, a higher information throughput than that of the macrodiversity channel.

The radio signals which are then processed by the receiving units 31 may originate from the same base station or from different base stations.

In the first case, the same scrambling code is assigned to the different units 31, which process channels differentiated by their channel-separation codes. This can be used especially in the following two cases:

1. In order to establish communication from the base station to the mobile station with an information throughput of $2^{k-L}.D$, although it is not possible to select, in the tree, a new code with spreading factor 2^{L-k} while obeying the overall constraint of orthogonality of the codes, the RNC can decide to form, from the same base station, multiple channels with lower individual throughputs, that is to say for which the spreading factors are greater than 2^{L-k}. The information throughput is then distributed between these channels which are processed separately by the receiving units 31 of the mobile station.

Figures 5 and 6 illustrate an example of this illustrative case. In the allocation shown diagrammatically in Figure 5, five channels are used by the base station to communicate by radio with five mobile stations. Each channel has a spreading factor of $2^3 = 8$, and thus an information throughput of D/8. If it is required, for example, to increase the information throughput of the communication established on the channel with code $c_{8,2}$ so as to make it change to a throughput of D/2 (spreading factor SF = 2), the natural way of doing so, while fully preserving the options for communicating in macrodiversity mode, consists in redistributing the other codes with

spreading factor 8 so as to release all the branches passing either through the code $c_{2,1}$, or through the code $c_{2,2}$, and to allocate this code $c_{2,1}$ or $c_{2,2}$ to the communication. This gives rise to a relatively substantial amount of signaling in order to carry out intracellular transfers of channels for mobile stations which are not directly involved with the increase in throughput. With the present invention, it is possible simply to allocate two additional channels to the communication, corresponding to the codes $c_{8,3}$ and $c_{4,4}$ in the example represented in Figure 6. In this specific case, three channels are formed towards the mobile station and processed by different receiving units of the station, which prevents, or at least limits, the options for operating in macrodiversity on the down link. This way of working does not require any signaling to the other mobile stations.

2. It is also possible to achieve a finer granularity of throughput by allocating multiple channels from the same base station. The case is considered of establishing a communication requiring an information throughput equal to $\alpha.D$, where α is a real number such that $\lceil\alpha.2^L\rceil = \sum_{i=0}^{L-1} a_i.2^i$, $\lceil\alpha.2^L\rceil$ is the integer equal to or immediately greater than $\alpha.2^L$, and the a_i are numbers each equal to 0 or to 1 and the sum of which is at least equal to 2. If m is the integer such that $0\leq m<L-1$ and if $L-1-m$ is the largest of the integers i for which $a_i = 1$, then $2^{-m-1}<\alpha\leq 2^{-m}-2^{-L}$. In this case, it is possible to select several codes of the tree obeying the overall orthogonality constraint, and with spreading factors SF_1, SF_2, etc., such that $\sum SF_n<2^{-m}$. The usable throughput of the communication is then lower than if a channel defined by a single spreading code were chosen (this channel would have an increased throughput equal to $2^{-m}.D$). In order to use

the minimum amount of throughput resources, $2^{n(i)}$ codes are selected with spreading factor $2^{L-i+n(i)}$ for each value of i such that $a_i = 1$, the n(i) being integers such that $0 \le n(i) \le i$.

Figure 7 illustrates this specific case in a particular case where $\alpha = 0.375$ ($a_{L-2} = a_{L-3} = 1$). It is a matter of increasing the throughput of the same communication as in the example of Figures 5 and 6, but to the value 0.375 × D. This can be achieved simply by allocating the code $c_{4,4}$ to form a supplementary channel ($n(L-2) = n(L-3) = 0$), which limits the macrodiversity options for the mobile station. It will be observed that this way of proceeding leaves the code $c_{8,3}$ available (or those codes situated on the branches downstream of $c_{8,3}$) for other communications, while by proceeding as in the case of Figure 6, that is to say by increasing the useful throughput to 0.5 × D, complete saturation of the resources of the cell would have been obtained.

There is a certain amount of freedom in the choice of the numbers n(i). For example, in the case of Figure 7, it would have been possible to decide to establish two supplementary channels, with codes $c_{8,7}$ and $c_{8,8}$, instead of the channel with code $c_{4,4}$, which corresponds to $n(L-2) = 1$ and $n(L-3) = 0$ instead of $n(L-2) = n(L-3) = 0$. In general, there will be a benefit in minimizing the number of receiving units required within the mobile station, which corresponds to the choice of Figure 7 in the example considered. This number is equal to $\sum_{\substack{i=0 \\ a_i=1}}^{L-1} 2^{n(i)}$.

When the different sets of information processed by the mobile station, once the macrodiversity mode has been dispensed with, originate from separate base stations, the receiving units 31 are allocated different scrambling codes. This implies that

the mobile station is capable of communicating with several adjacent base stations. This operating mode may therefore be activated at the time when the mobile station is currently operating in macrodiversity mode. If the code resources of one of the base stations are saturated (for example the configuration of Figure 6), and if it is necessary to increase the quantity of information to be transmitted to the mobile station operating in macrodiversity mode, the RNC may cause the base station of an adjacent cell, via the interface *Iu* if it directly controls this base station or by way of the interface *Iur* and of an auxiliary RNC ("drift RNC"), to transmit the supplementary information, which causes a loss, at least in part, of the macrodiversity gains.

The conditions under which the RNC decides to dispense with macrodiversity may be very varied. The conditions examined above relate to the complete or relative saturation of the code resources which can be allocated in certain cells. Other elements may also play a part in this decision. Mention may be made of:

- the fact that the communication for which macrodiversity is likely to be dispensed with is otherwise the subject of another diversity technique, such as a technique of repetition in the event of poor reception (ARQ);
- in the case in which a mobile station is already operating in macrodiversity mode, the fact of observing, within the combining unit 38, that the macrodiversity gain is relatively low on a down link (for example below a certain threshold), etc.

Furthermore, the manager of the cellular network may decide, as a function of the installation characteristics of each base station and of its environment, to make more or less stringent the conditions under which the macrodiversity mode can be

dispensed with on the down link for communications involving this base station.

These various conditions are established by the installer at the time when the RNC is configured.

CLAIMS

1. Method for radio communication between a mobile station (14, 14a, 14b) and a cellular-network infrastructure including a set of base stations (13), in which the mobile station includes at least two receiving units (31) for processing, in macrodiversity mode, respective radio signals sent out by at least two separate base stations and carrying identical information, characterized in that, when specified conditions are fulfilled, the macrodiversity mode is at least partially dispensed with for the mobile station, one or more of the base stations is or are made to send the mobile station at least two radio signals carrying different sets of information, and the mobile station is made to have its receiving units process these radio signals so as to receive the said different sets of information.

2. Method according to Claim 1, in which, when at least some of the specified conditions are fulfilled, the said radio signals carrying different sets of information are sent out by the same base station (13).

3. Method according to Claim 2, in which the base station (13), in the case of the down communication direction, operates with multiple communications channels defined by channel-separation codes selected from a set of codes with variable spreading factor in a defined range, the channel-separation codes being selected with spreading factors depending on the information throughputs required respectively on the channels, with an overall constraint of orthogonality between the codes employed at every instant by the base station.

4. Method according to Claim 3, in which, in cases where a communication is established from the base station (13) to the mobile station (14, 14a, 14b) with

an information throughput corresponding to a first spreading factor lying within the said defined range and such that it is not possible to select a new code while obeying the overall orthogonality constraint, multiple channels are formed, defined respectively by codes obeying the overall orthogonality constraint and the respective spreading factors of which are greater than the first spreading factor, the information throughput of the communication being distributed between these multiple channels which transport respective radio signals each processed by at least one of the receiving units (31) of the mobile station.

5. Method according to Claim 3 or 4, in which the spreading factors of the codes of the set are of the form 2^{L-k}, L being a positive integer and k an integer variable such that $0 \leq k \leq L$, a channel-separation code of the form 2^{L-k} corresponding to an information throughput of $2^{k-L}.D$, where D is a defined maximum code throughput, and in which, in cases where a communication is established from the base station (13) to the mobile station (14, 14a, 14b) requiring an information throughput equal to $\alpha.D$ with $2^{-m-1} < \alpha \leq 2^{-m} - 2^{-L}$ and m an integer such that $0 \leq m < L-1$, at least two codes of the set are selected obeying the overall orthogonality constraint in such a way that the sum of the inverses of the spreading factors of the codes selected is less than 2^{-m}, so as to form multiple channels defined respectively by the selected codes, the information throughput of the communication being distributed between these multiple channels which transport respective radio signals each processed by at least one of the receiving units (31) of the mobile station.

6. Method according to Claim 5, in which, in the said cases where a communication is established from the base station (13) to the mobile station (14, 14a, 14b) requiring an information throughput equal to $\alpha.D$,

the integer $\lceil \alpha.2^L \rceil$ equal to or immediately greater than $\alpha.2^L$ being of the form $\lceil \alpha.2^L \rceil = \sum_{i=0}^{L-1} a_i.2^i$, where the a_i are each equal to 0 or to 1, $2^{n(i)}$ codes with spreading factor $2^{L-i+n(i)}$ are selected for each value of i such that $a_i = 1$, the n(i) being integers such that $0 \le n(i) \le i$.

7. Method according to Claim 6, in which the numbers n(i) are chosen in such a way as to minimize the number $\sum_{\substack{i=0 \\ a_i=1}}^{L-1} 2^{n(i)}$.

8. Method according to Claim 1, in which, when at least some of the specified conditions are fulfilled, the said radio signals carrying different sets of information are sent out respectively by at least two separate base stations (13).

9. Method according to Claim 8, in which the said radio signals carrying different sets of information are sent out respectively by at least first and second separate base stations after the following three conditions have been fulfilled:

- the mobile station is currently operating in macrodiversity mode in order to process radio signals sent out respectively by the first and second base stations and carrying identical information;
- channel-allocation resources of the first base station are saturated; and
- an increase in the quantity of information to be transmitted to the mobile station is required.

10. Control equipment of a cellular-radio communications network comprising a set of base stations (13) and of mobile stations (14, 14a, 14b), at least some of the mobile stations including at least two receiving units (31) in order, in macrodiversity mode, to process respective radio signals sent out by at least two separate base stations and carrying identical information, the equipment (12) comprising

means (16) for control of at least one base station for allocating, to the base station, radio communications resources for a down communications direction and for causing corresponding signaling messages to be sent to mobile stations served by this base station, characterized in that the control means are configured to cause a mobile station at least partially to dispense with the macrodiversity mode when the specified conditions are fulfilled, while causing one or more of the base stations to send out, to the mobile station, at least two radio signals carrying different sets of information, and while causing the mobile station to have its receiving units process these radio signals so as to receive the said different sets of information.

11. Equipment according to Claim 10, in which, when at least some of the specified conditions are fulfilled, the control means (16) cause the same base station (13) to send out the said radio signals carrying different sets of information.

12. Equipment according to Claim 11, in which the base station (13), in the case of the down communication direction, operates with multiple communications channels defined by channel-separation codes selected by the control means (16) from a set of codes with variable spreading factor in a defined range, the channel-separation codes being selected with spreading factors depending on the information throughputs required respectively on the channels, with an overall constraint of orthogonality between the codes employed at every instant by the base station.

13. Equipment according to Claim 12, in which, in cases where a communication is established from the base station (13) to the mobile station (14, 14a, 14b) with an information throughput corresponding to a first spreading factor included in the said defined range and such that it is not possible to select a new code while

obeying the overall orthogonality constraint, the control means (16) form multiple channels, defined respectively by codes obeying the overall orthogonality constraint and the respective spreading factors of which are greater than the first spreading factor, the information throughput of the communication being distributed between the said multiple channels which transport respective radio signals each processed by at least one of the receiving units (31) of the mobile station.

14. Equipment according to Claim 12 or 13, in which the spreading factors of the codes of the set are of the form 2^{L-k}, L being a positive integer and k an integer variable such that $0 \leq k \leq L$, a channel-separation code of the form 2^{L-k} corresponding to an information throughput of $2^{k-L}.D$, where D is a defined maximum code throughput, and in which, in cases where a communication is established from the base station (13) to the mobile station requiring an information throughput equal to $\alpha.D$ with $2^{-m-1} < \alpha \leq 2^{-m} - 2^{-L}$ and m an integer such that $0 \leq m < L-1$, the control means (16) select at least two codes of the set obeying the overall orthogonality constraint in such a way that the sum of the inverses of the spreading factors of the codes selected is less than 2^{-m}, so as to form multiple channels defined respectively by the selected codes, the information throughput of the communication being distributed between these multiple channels which transport radio signals each processed by at least one of the receiving units (31) of the mobile station.

15. Equipment according to Claim 14, in which, in the said cases where a communication is established from the base station (13) to the mobile station (14, 14a, 14b) requiring an information throughput equal to $\alpha.D$, the integer $\lceil \alpha.2^L \rceil$ equal to or immediately greater than $\alpha.2^L$ being of the form $\lceil \alpha.2^L \rceil = \sum_{i=0}^{L-1} a_i . 2^i$, where the a_i

are each equal to 0 or to 1, the control means (16) select $2^{n(i)}$ codes with spreading factor $2^{L-i+n(i)}$ for each value of i such that $a_i = 1$, the n(i) being integers such that $0 \leq n(i) \leq i$.

16. Equipment according to Claim 15, in which the numbers n(i) are chosen by the control means (16) in such a way as to minimize the number $\sum_{\substack{i=0 \\ a_i=1}}^{L-1} 2^{n(i)}$.

17. Equipment according to Claim 10, in which, when at least some of the specified conditions are fulfilled, the control means (16) cause at least two separate base stations (13) to send out the said radio signals carrying different sets of information.

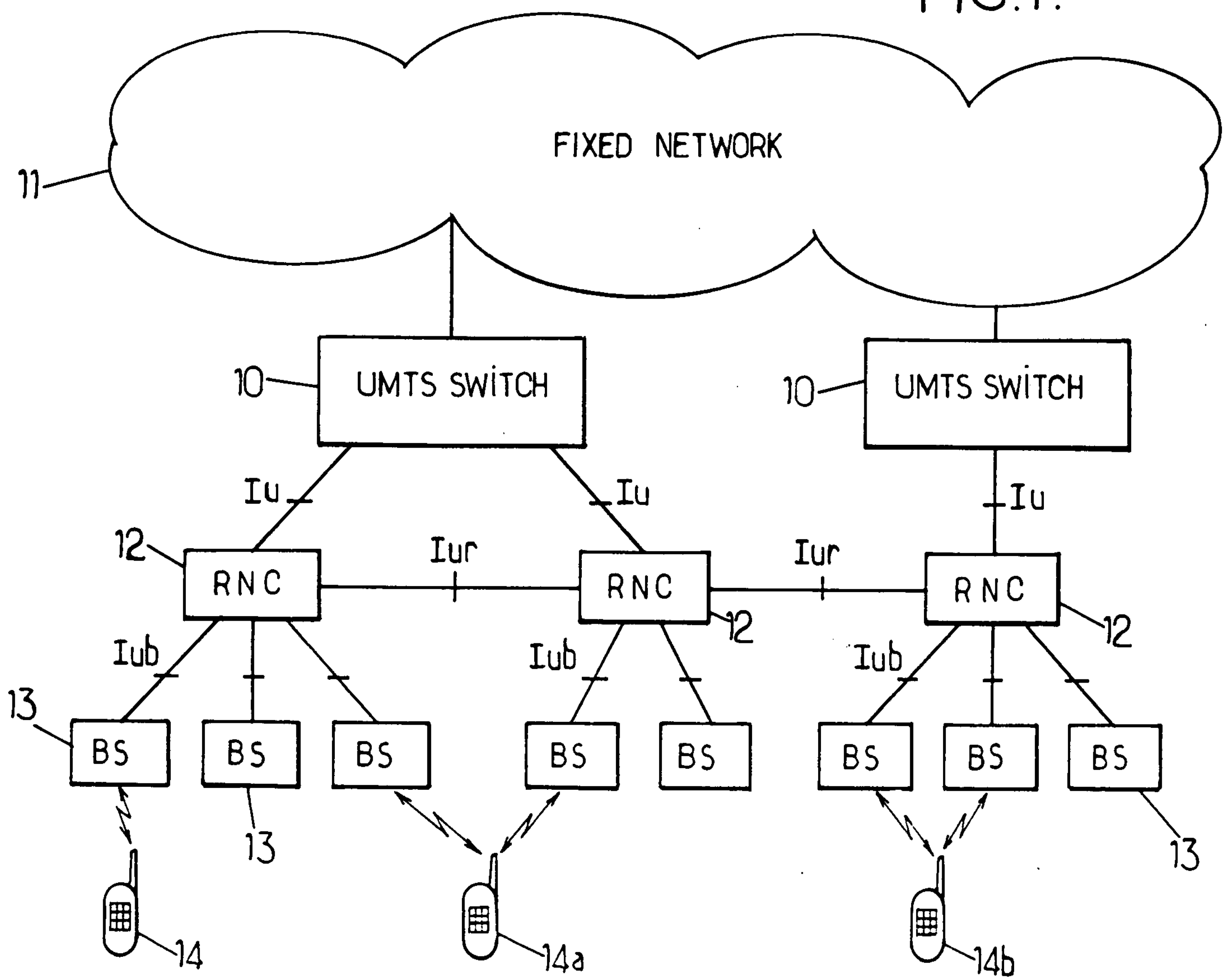
18. Equipment according to Claim 17, in which the control means cause at least first and second separate base stations to send out respectively the said radio signals carrying different sets of information after the following three conditions have been fulfilled:

- the mobile station is currently operating in macrodiversity mode in order to process radio signals sent out respectively by the first and second base stations and carrying identical information;
- channel-allocation resources of the first base station are saturated; and
- an increase in the quantity of information to be transmitted to the mobile station is required.

19. Mobile radio-communications station with a cellular network the infrastructure of which includes a set of base stations (13), comprising at least two receiving units (31) for processing respective radio signals, means (32) for allocating radio resources to the receiving units in response to signaling messages received from the infrastructure of the network, and combining means (38) for combining outputs of the receiving units in a macrodiversity mode in which at least some of the said radio signals are sent out by at

least two separate base stations and are carrying identical information, characterized in that, in response to certain of the signaling messages, the allocation means at least partially dispense with the macrodiversity mode, deactivating the combining means, the receiving units then processing at least two radio signals carrying different sets of information.

FIG.1.



FIXED NETWORK
11
10
UMTS SWITCH
10
UMTS SWITCH
Iu
Iu
Iu
12
RNC
Iur
RNC
12
Iur
RNC
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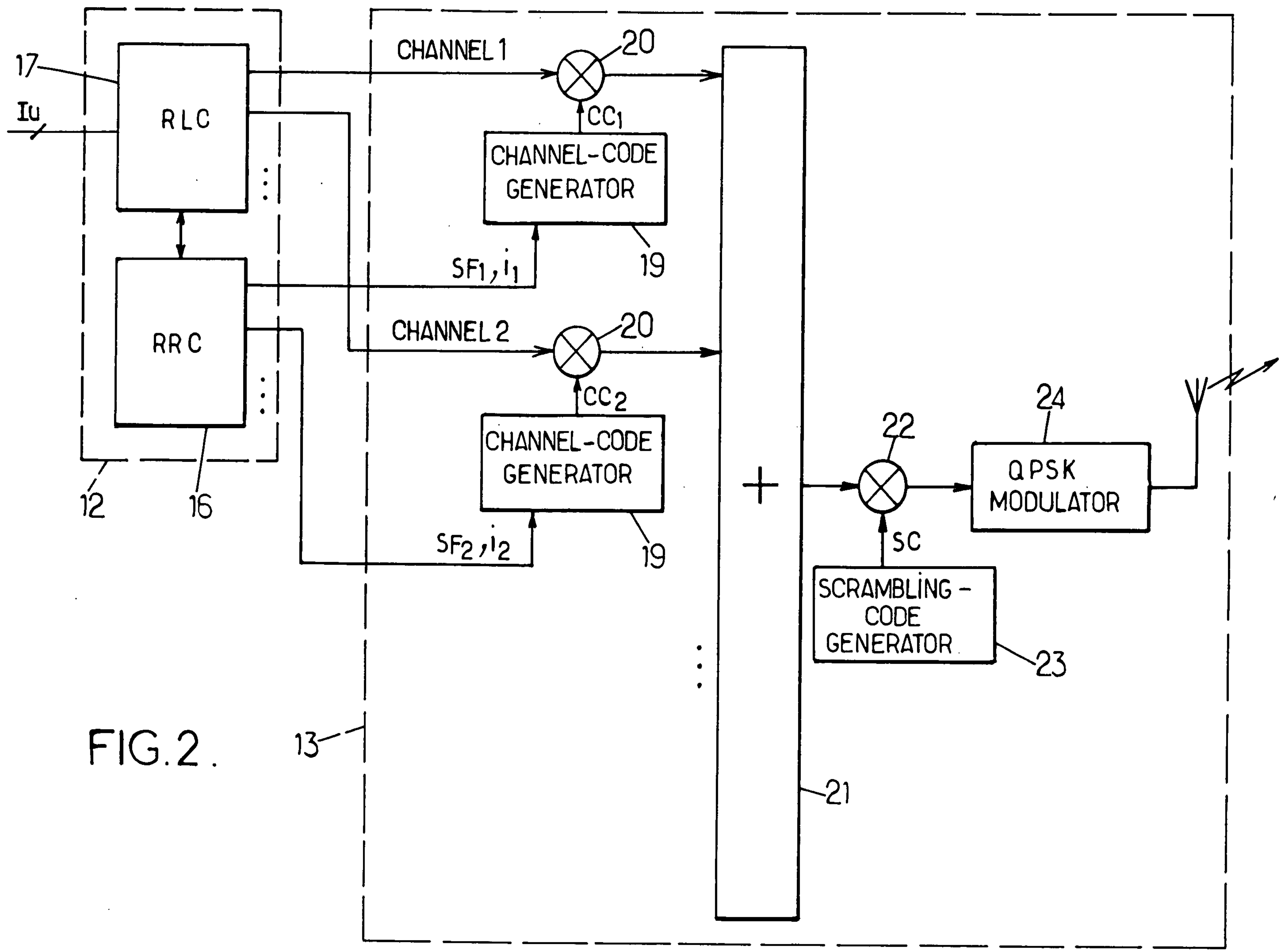
13
13
14
14a
14b



17
Iu
RLC
RRC
12
16
CHANNEL 1
CHANNEL 2
20
CC1
CC2
CHANNEL-CODE GENERATOR
19
SF1, i1
SF2, i2
13
+
21
22
SC
SCRAMBLING-CODE GENERATOR
23
QPSK MODULATOR
24

FIG. 2.

FIG.3.

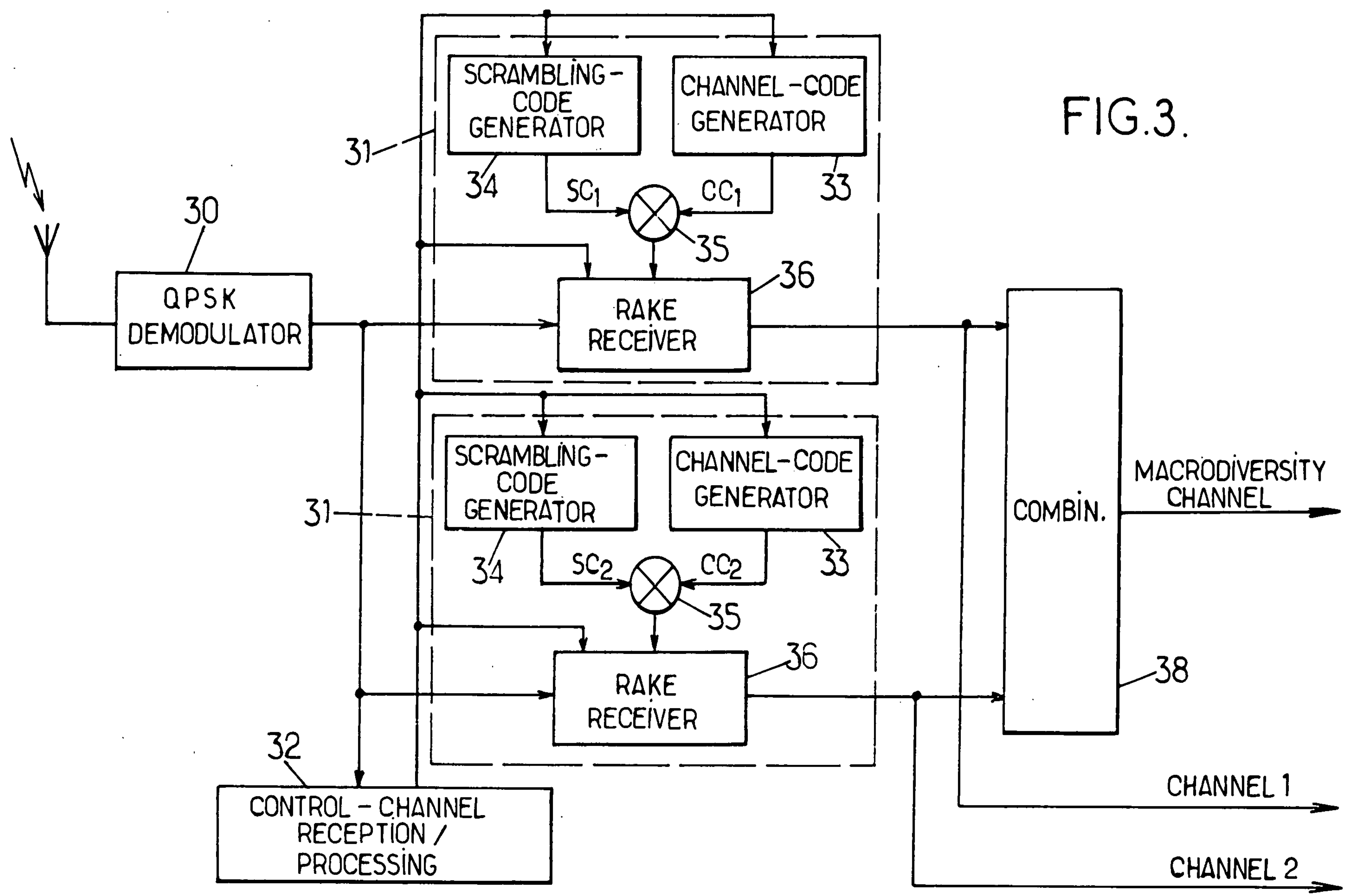
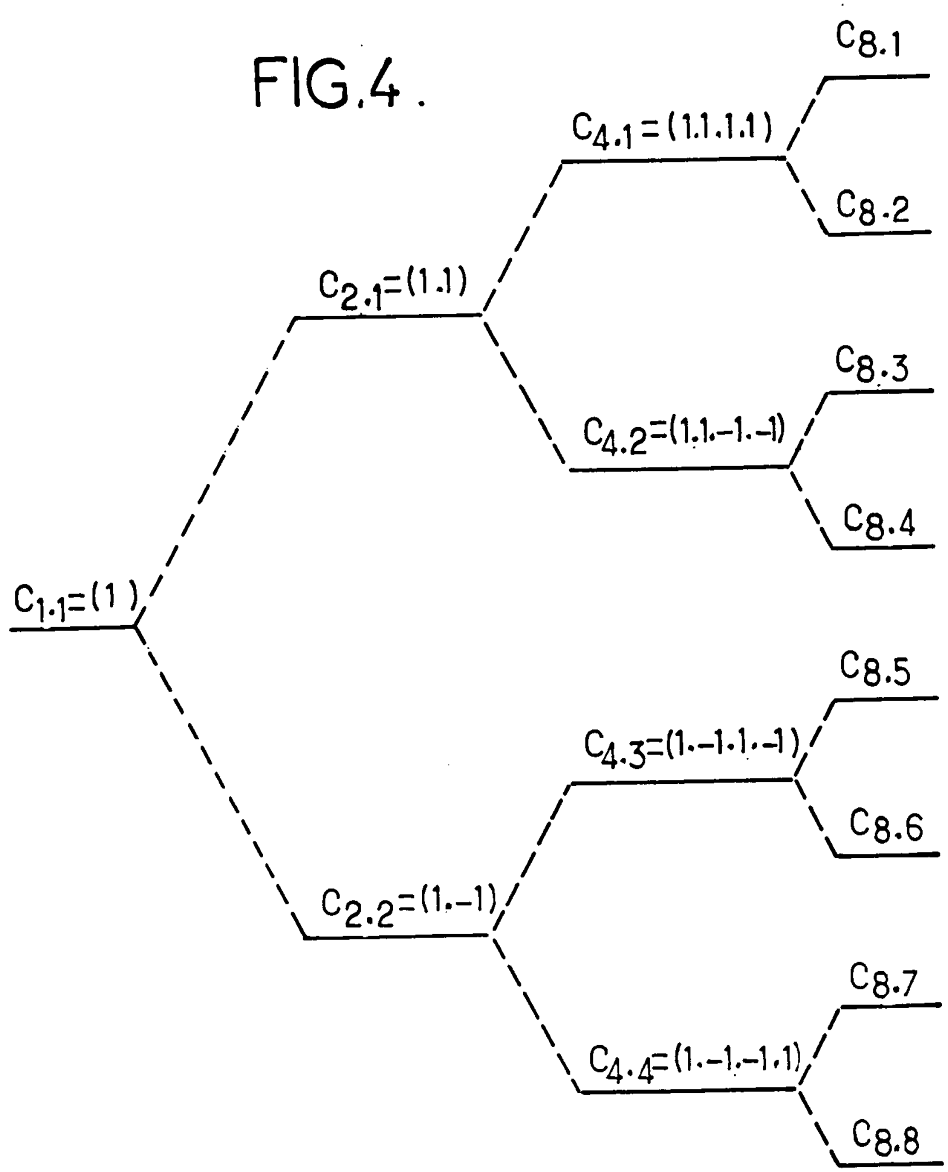

30
QPSK
DEMODULATOR
31
SCRAMBLING-
CODE
GENERATOR
34
CHANNEL-CODE
GENERATOR
33
SC1
CC1
35
RAKE
RECEIVER
36
SCRAMBLING-
CODE
GENERATOR
CHANNEL-CODE
GENERATOR
SC2
CC2
32
CONTROL-CHANNEL
RECEPTION /
PROCESSING
COMBIN.
38
MACRODIVERSITY
CHANNEL
CHANNEL 1
CHANNEL 2

FIG.4.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$C_{2.1}=(1.1)$
$C_{2.2}=(1.-1)$
$C_{4.1}=(1.1.1.1)$
$C_{4.2}=(1.1.-1.-1)$
$C_{4.3}=(1.-1.1.-1)$
$C_{4.4}=(1.-1.-1.1)$
$C_{8.1}$
$C_{8.2}$
$C_{8.3}$
$C_{8.4}$
$C_{8.5}$
$C_{8.6}$
$C_{8.7}$
$C_{8.8}$

FIG.5.

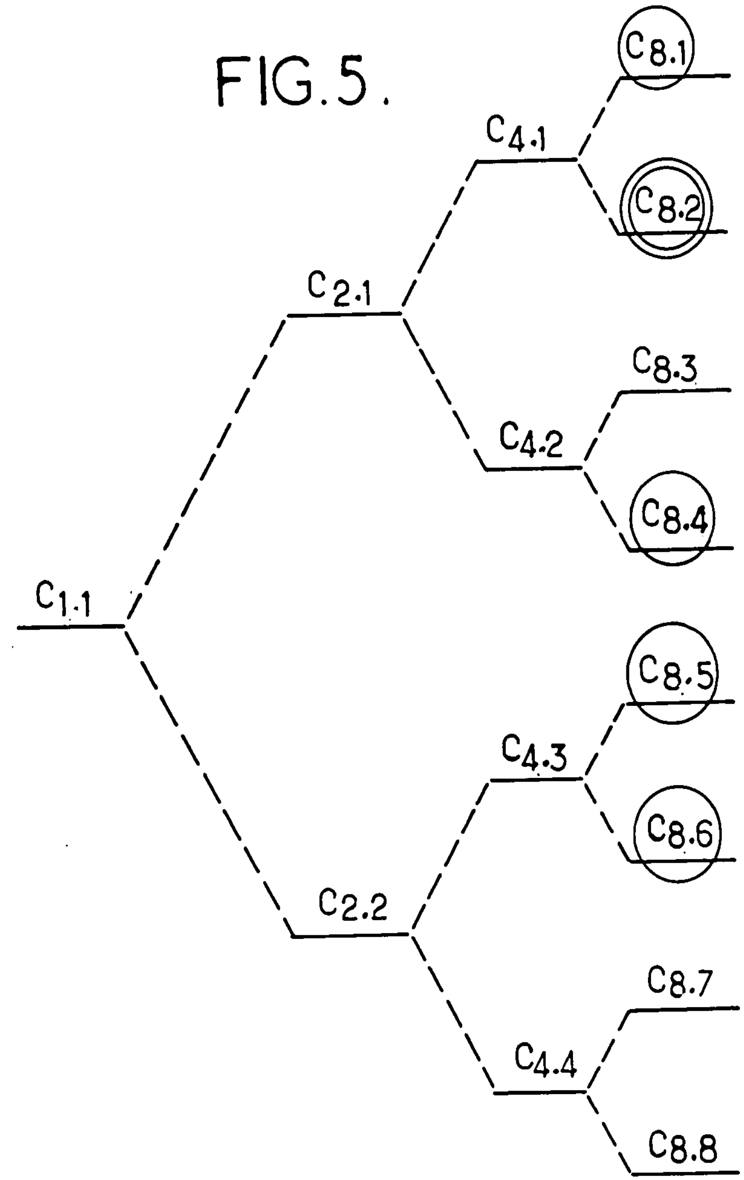
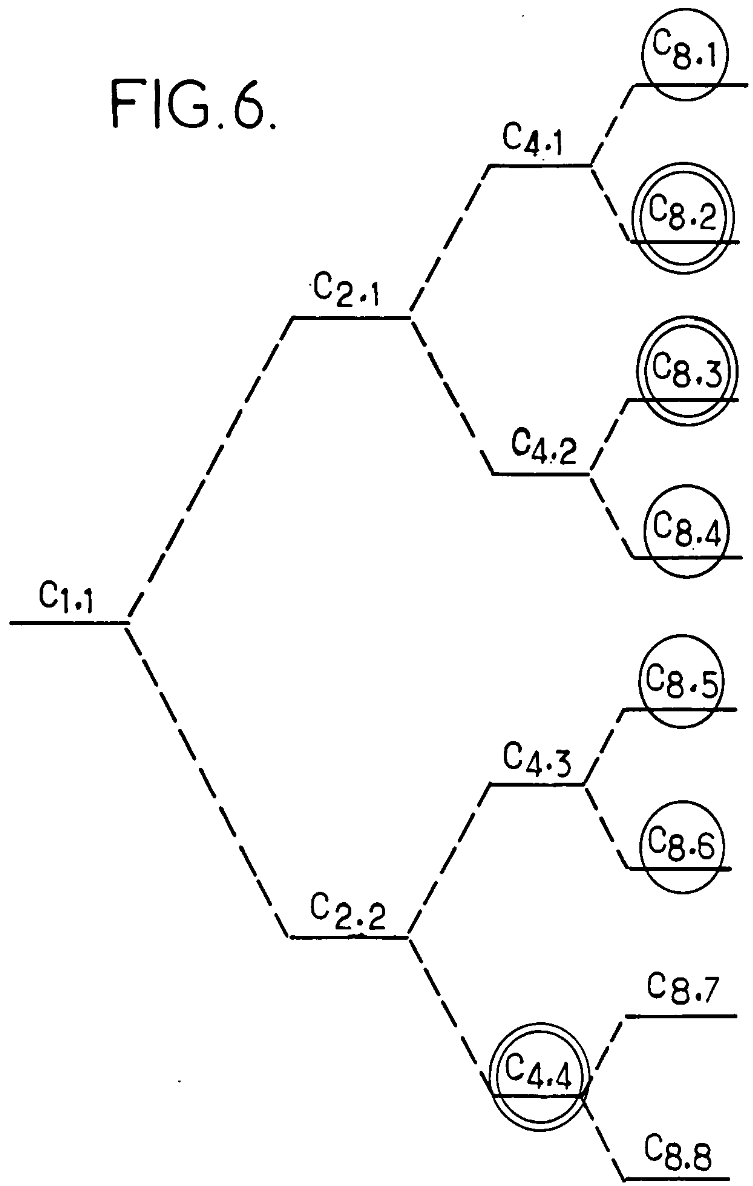
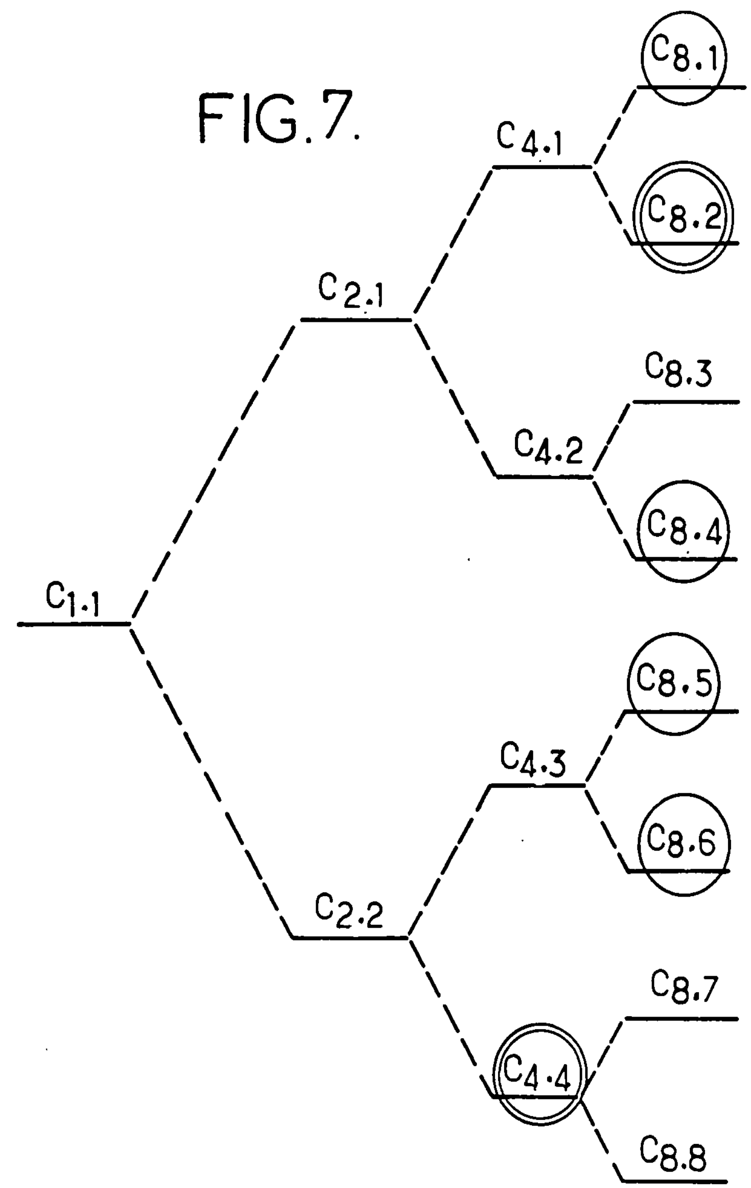

$C_{1.1}$
$C_{2.1}$
$C_{2.2}$
$C_{4.1}$
$C_{4.2}$
$C_{4.3}$
$C_{4.4}$
$C_{8.1}$
$C_{8.2}$
$C_{8.3}$
$C_{8.4}$
$C_{8.5}$
$C_{8.6}$
$C_{8.7}$
$C_{8.8}$

FIG.6.



$C_{1.1}$
$C_{2.1}$
$C_{2.2}$
$C_{4.1}$
$C_{4.2}$
$C_{4.3}$
$C_{4.4}$
$C_{8.1}$
$C_{8.2}$
$C_{8.3}$
$C_{8.4}$
$C_{8.5}$
$C_{8.6}$
$C_{8.7}$
$C_{8.8}$

FIG.7.



$C_{1.1}$
$C_{2.1}$
$C_{2.2}$
$C_{4.1}$
$C_{4.2}$
$C_{4.3}$
$C_{4.4}$
$C_{8.1}$
$C_{8.2}$
$C_{8.3}$
$C_{8.4}$
$C_{8.5}$
$C_{8.6}$
$C_{8.7}$
$C_{8.8}$